AMERICAN JOURNAL OF INDUSTRIAL MEDICINE 42:502–510 (2002)

Increased Reporting of Occupational Hearing Loss: Workers' Compensation in Washington State, 1984–1998

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Background *Workers' compensation claims for hearing loss increased two-fold during 1984–1991 in Washington State.*
Methods *This population-based descriptive study examined 27,019 claims filed during 1984–1998 and accepted for hearing loss, in the workers' compensation jurisdiction that covers nearly all non-federal workers in Washington State.*
Results *The number of claims increased 12-fold during 1984–1998. The annual incidence reached 2.6/1,000 workers statewide, and 70/1,000 in the most impacted industry. The increase involved all ages over 35 years, especially claimants over 65 years. Only 4% of providers accounted for 66% of claims. Most claimants (90%) received permanent partial disability compensation. In 1998, identifiable costs exceeded $57 million dollars.*
Conclusions *The striking increase in claims is probably largely due to reporting phenomena unrelated to current work circumstances. However, occupational hearing loss is probably much more common than usually recognized, and contemporary workers may still face substantial risk for hearing loss.* Am. J. Ind. Med. 42:502–510, 2002.

KEY WORDS: hearing loss; noise-induced; epidemiology; incidence; health care costs; workers' compensation; occupational diseases

INTRODUCTION

Hearing loss is a common health problem, affecting about 40 million Americans, with possibly up to one-third of cases being at least partially attributable to noise [NIH, 1990; NCHS, 1994]. The Occupational Safety and Health Administration (OSHA) instituted the Noise Standard in 1971 and the Hearing Conservation Amendment in 1983 [OSHA, 1971, 1983]. When workplace noise is excessive, employers are required to institute noise control measures, if feasible, and to maintain a hearing conservation program that provides training, hearing protection devices, and annual audiometric monitoring for exposed workers. Even before the OSHA regulations were promulgated, many of these protective measures were already in common practice, particularly among large manufacturers.

A previous study of workers' compensation claims filed in Washington State for occupational hearing loss found that

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Contract grant sponsor: National Institute for Occupational Safety and Health; Contract grant number: R01-OH03894; Contract grant sponsor: Accident and Medical Aid Funds of the State of Washington, Department of Labor and Industries.
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Accepted 2 September 2002
DOI 10.1002/ajim.10146. Published online in Wiley InterScience (www.interscience.wiley.com)

the annual number of accepted claims doubled, and the annual disability costs tripled, during 1984–1991, primarily during the last half of the study period [Daniell et al., 1998a,b]. The study also observed a 40-fold transient increase in hearing-related claims filed and accepted at one large worksite during 1988 through 1990. The present study, therefore, examined workers' compensation claims filed in this same jurisdiction through 1998, to determine whether the previously observed growth in occupational hearing loss claims persisted in subsequent years, and to characterize any associated patterns or temporal trends in demographic, clinical, or administrative variables.

MATERIALS AND METHODS

This is a population-based descriptive study of all identifiable Washington State Department of Labor & Industries (DLI) workers' compensation claims accepted for occupational hearing-related conditions, with claim filing dates between January 1, 1984 and December 31, 1998. The study used only existing data and collected no new data. Study procedures were reviewed and approved by the University of Washington Human Subjects Review Committee.

Data Sources

The DLI industrial insurance computerized administrative database was the primary data source. The DLI regulates workers' compensation covering nearly all full- and part-time non-federal workers in the state, except for workers covered by special laws or programs, corporate officers, self-employed individuals, and domestic employees. About 400 larger employers have Self-Insured programs, covering approximately one-third of workers in the DLI jurisdiction: 0.5–0.6 million full-time equivalent (FTE) workers annually during 1992 through 1998. Self-Insured programs are regulated by DLI, and report limited information about each claim to DLI. The DLI administers the State Fund, which insured 0.9–1.5 million FTE workers annually during 1984 through 1998. The DLI also manages claims for, but does not insure, employees of civilian contractors at the U.S. Department of Energy (DOE) site at Hanford, Washington.

The study also used data from a manual review of non-computerized medical records in a subsample of claims, conducted previously for a study of claims filed during 1984 through 1991 for hearing-related conditions (using identification criteria equivalent to those in the present study) [Daniell et al., 1998b]. The sampling strategy and record review procedures were described previously.

Study Sample

The study sample consisted of all State Fund, Self-Insured, and Hanford/DOE claims filed for hearing-related conditions between January 1, 1984 and December 31, 1998, and accepted for coverage. Claims were identified by the condition reported at the time of claim filing (coded with U.S. Department of Labor Z-16.2 codes): (a) nature of illness or injury = "hearing loss," and/or (b) source of illness or injury = "noise."

The sample consisted of 27,019 claims extracted from the DLI database at three points in time, including: (1) the previously described claims filed during 1984–1991, extracted in mid-1993 (n = 4,513, plus 46 Hanford/DOE claims not included in previous publications) [Daniell et al., 1998a,b]; (2) claims filed during 1992–1996, extracted in early 1998 and updated in early 2000 (n = 12,280); and (3) claims filed during 1997–1998, extracted in early 2000 (n = 10,180). The data extraction in 2000 was done for a separate study, and did not include all of the variables in the previously extracted samples (e.g., provider identification).

The status of a claim (accepted, rejected, pending) can change over time. The temporal stability of claim status was evaluated for claims filed in 1992–1996, and extracted in both 1998 and 2000. The later extraction yielded 349 claims not previously identified as accepted; and 64 claims were no longer identified as accepted. The net change primarily involved claims filed in the last year of that period, 1996 (+5.7%; other years, $\leq$0.5% increase), and State Fund claims (+2.4%; Self Insured, +0.4%; DOE, +0.3%). By extrapolation, claims with 1998 filing dates may be underascertained by about 6%; ascertainment probably was near complete for other years.

Accepted Condition: "Occupational Hearing Loss"

Misclassification can occur when administrative data are used to identify workers' compensation claims that represent a specific condition. Based on a previous manual review of non-computerized medical records for a subsample of claims [Daniell et al., 1998b], we estimate that about 95% of the studied claims truly represent claims accepted for hearing loss related to chronic noise exposure. In the reviewed subsample of 1984–1991 claims, most claims included a physician diagnosis and were accepted by DLI for hearing loss that was at least partially attributable to chronic noise exposure, and about 11% (95% confidence interval, 6–15%) represented other, primarily acute hearing-related conditions. The record review was not repeated for 1992–1998 claims. However, given that the percentage of claimants older than 65 years rose from 6% of 1984–1991 claims to 46% of 1992–1998 claims (see Results), and given that DLI requires that claims for acute conditions be filed within one year after an injury, the proportion of claims representing conditions other than hearing loss related to chronic noise exposure is probably much less than 11%.

All studied claims were accepted for workers' compensation coverage, indicating that the hearing loss in each claim

had been judged to be at least partially occupational in origin, after opportunities for employer protest and independent medical examination in questioned cases.

Data Analysis

Data analyses were descriptive [SPSS, 1999]. Analyses of temporal patterns focused on the previously studied 8-year period, 1984–1991 (claim filing dates), especially 1984–1987, when the annual number of claims was relatively stable; and made comparisons with the newly studied 7-year period, 1992–1998. Non-normal distributions were characterized by medians and inter-quartile intervals (25th–75th percentiles).

Hearing Impairment

The laterality and percentage of work-related hearing impairment are not coded in the DLI database. The DLI calculates hearing impairment from audiometric data, using American Medical Association guidelines [Doege and Houston, 1993; DLI, 2000]. Since 1995, the DLI has allowed up to an additional 5% for tinnitus, depending on severity. For this study, binaural-equivalent hearing impairment was estimated from the disability settlement amount, divided by the DLI scheduled dollar value for total loss of hearing in both ears (based on the ''date of manifestation,'' up to $65,023 for dates in 1998). The manual review of 1984–1991 claims found this indirect estimate correlated highly ($r = 0.91$) with the impairment rating in non-computerized records.

Incidence Rates

Claims incidence rates were calculated with worker-hours reported to DLI annually by all employers, within specific DLI industrial insurance risk classes (industry codes). These data encompass the entire population of workers covered by DLI, providing denominator data for statewide and industry-specific incidence rates. Reported hours were divided by 2,000 (40 hr/week, 50 weeks/year), to derive FTE workers. Risk classes were categorized using modified DLI definitions [DLI, 1997]. Incidence rates could not be calculated for Self-Insured claims filed in 1984–1991, because worker-hour data were not available.

RESULTS

Number of Claims

The number of claims accepted annually in Washington state for occupational hearing-related conditions was stable during 1984 through 1987 (mean, 430 claims/year; standard deviation (SD), 31; Fig. 1). However, the annual number of claims subsequently increased more than 12-fold to a high of 5,394 accepted claims with 1998 filing dates.

Jurisdiction

Of the total 27,019 claims, 61% were covered by the State Fund, and 36% by Self-Insured employers; fewer than 3% were for Hanford/DOE non-federal employees. Hanford/DOE claims are managed by the State Fund, and were combined with State Fund claims for the present data analysis. The increase in number of claims manifested sooner for Self-Insured than State Fund claims (Fig. 1). However, State Fund claims eventually showed a larger relative increase across the overall study period, 16-fold, than did Self-Insured claims, which increased only six-fold and appeared to level off by the end of the study period.

Claimant Age

The increase in claims was most pronounced for older individuals (Fig. 2). Individuals older than 65 years at the time of claim filing accounted for only 8% of claims during 1984–1987 (mean 35 claims/year, SD 6). However, in 1998 this age group accounted for 46% of all claims ($n = 2,459$), a 71-fold increase in number of claims. The relative increases in the annual number of claims over the same period were progressively less with younger claimant age: 56–65 years of age, 10-fold increase; 46–55 years, 8-fold; and 36–45 years, 5-fold. The annual number of claims from 16–35 year old claimants showed no increase over the same period.

Incidence Rate

The growth in statewide incidence of hearing-related claims mirrored the growth in annual number (Fig. 1). Among workers with State Fund coverage, there was an average of only 0.30 claims for every 1,000 FTE workers, each year during 1984–1991, which increased to an annual average of 1.84 during 1992–1998 and a peak of 3.06 in 1998. During the same period, 1992–1996, the average incidence of Self-Insured claims was 1.55/1,000 worker-years, reaching a peak value of 1.92 in 1996.

Industries

Some industries were much more highly impacted than others by the growth in number of hearing loss claims (Table I). The proportion of claims from production industries (i.e., industries that produce or extract raw resources) declined from 1984–1991 to 1992–1998, and increased in construction and service industries. During 1992–1998, the incidence of hearing loss claims generally was highest in production and construction industries, averaging about nine claims/1,000 worker-years, or more than five times the

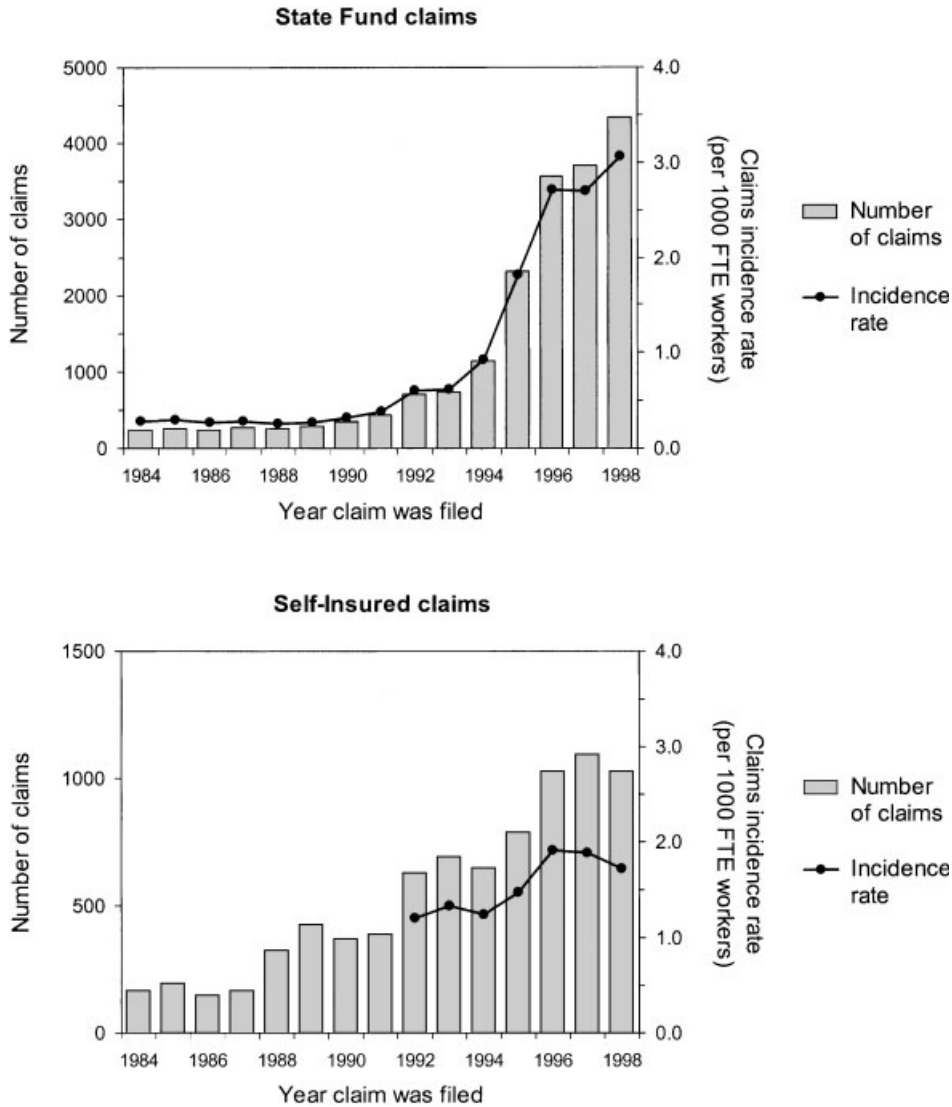

FIGURE 1. Workers' compensation claims for occupational hearing loss in Washington State. Claims administered by the State of Washington for the federal Department of Energy (DOE) are included with "State Fund" claims in this figure.

overall statewide incidence. Together, these industries accounted for half of all hearing loss claims (49.5%) but only 9.5% of the state work force. The manufacturing and service sectors each accounted for about 20% of claims, with industry-specific incidence rates that generally were lower than those seen in production and construction industries. The logging industry showed the highest industry-specific incidence rate, 70 claims/1,000 worker-years during 1997–1998.

Providers

There were 1,123 attending providers identified for 12,040 claims filed during 1992–1996 (94%). Provider data must be interpreted cautiously, because an identification number can represent more than one provider, such as a provider group or institution. Otolaryngologists accounted for only 15% of identified providers but over half of all claims (55%). The majority of identified providers (63%) were family practice, internal medicine, and general practice physicians, although they accounted for only 26% of claims. Occupational medicine physicians accounted for a very small proportion of identified providers (1.4%) and a smaller proportion of claims (0.7%).

A small number of providers accounted for the majority of claims: 42 providers were identified on at least 10 claims/year during this period, accounting for 66% of all claims; and 31% of claims were linked to only seven attending providers, who were identified on at least 50 claims/year (Fig. 3). Conversely, about half of all identified providers (54%) were

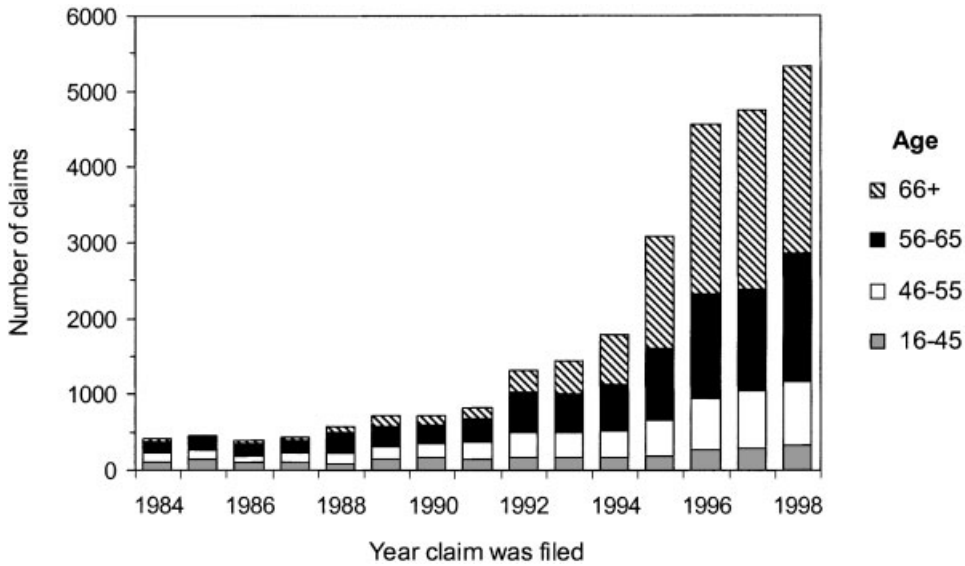

FIGURE 2. Workers' compensation claims for occupational hearing loss, by claimant age in Washington State.

the provider on only one hearing loss claim during the entire 5-year period, 1992–1996, together accounting for only 5% of claims.

Impairment and Workers' Compensation Costs

Most claims accepted for hearing-related conditions also received compensation for permanent partial disability (n = 24,309; 90%). The median amount of compensated hearing impairment was estimated to be 18.4% loss of binaural-equivalent hearing ability (inter-quartile interval, 8.2–30.9%), across all compensated 1992–1998 claims. The median amount of compensated impairment increased with age, and was consistently higher in State Fund claims than Self-Insured claims at all ages by 5–8% (absolute percent; Fig. 4).

It should be noted that the DLI does not allow reduction of hearing-impairment ratings for the estimated contribution from presbycusis or non-occupational noise. Therefore, particularly for older claimants, the amount of hearing impairment covered by disability compensation can reflect more than the amount of impairment that is truly attributable to occupational noise.

Disability settlements rose from an average annual sum of $1.9 million ($1.9M) during 1984–1987, to an annual sum of $45.7M in 1998 alone (Fig. 5). Annual sums of reimbursed medical expenses for State Fund claims rose from $0.9M to $10.7M across the same period (medical expense data were not available for Self-Insured claims). During 1992–1998, the median medical cost associated with a State Fund claim was $2,820, and the median disability settlement for a compensated claim was $7,180 (State Fund and Self-Insured). Without considering the medical costs of Self-Insured claims, these identifiable costs amounted to $243 million during the 7-year period, 1992–1998.

DISCUSSION

Washington state has experienced a striking increase in cases of occupational hearing loss reported to the state workers' compensation system, which contrasts sharply with the steady decline that occurred in the overall number of claims during the same period in this jurisdiction [Silverstein et al., 2000]. From 1987 to 1998, there was more than a twelve-fold increase in the number of claims accepted for occupational hearing conditions, at least 90–95% of which represented hearing loss related to chronic noise exposure. The annual number of claims for Self-Insured employers appeared to level off toward the end of the study period. However, the number of State Fund claims continued to rise, and the seeming decline in Self-Insured claims might only be an administrative artifact, in that Self-Insured claims are not reported to DLI until they are fully resolved. By 1998, the annual incidence rate reached 2.6 claims/1,000 workers, averaged across the entire work force, and reached as high as 70 claims/1,000 workers in the most affected industry, logging. Most claims (90%) received compensation for permanent partial disability. The annual summed costs of disability compensation increased more than twenty-fold across the study period. In 1998 alone, this amounted to $45.7 million, plus more than $11 million for medical expenses.

The causes of these increases are not clear. This study cannot distinguish if the increase in claims reflects any

TABLE I. Workers' Compensation Claims for Occupational Hearing Loss, by Industry and Time Period (Washington State)*

	Claims filed 1984–1991	Claims filed 1992–1998*		Claims filed 1997–1998*
Industry	**Total number (%)**	**Total number (%)**	**Incidence** (10^{-3} FTE-years)**	**Incidence (10^{-3} FTE-years)**
Production	1,857 (40.7)	5,653 (25.2)	9.2	11.3
Lumber milling	550 (12.1)	2,028 (9.0)	17.7	24.4
Logging	182 (4.0)	1,387 (6.2)	49.8	70.0
Pulp and paper	436 (9.6)	1,119 (5.0)	19.7	16.4
Ore smelting and refining	613 (13.4)	563 (2.5)	10.9	11.3
Farming	21 (0.5)	283 (1.3)	0.9	1.8
Mining and quarrying	51 (1.1)	233 (1.0)	10.8	16.9
Construction	750 (16.5)	5,461 (24.3)	9.0	13.1
Road construction	113 (2.5)	927 (4.1)	26.0	35.0
Carpentry	99 (2.2)	769 (3.4)	6.8	9.2
Plumbing, HVAC, sheet metal†	132 (2.9)	668 (3.0)	8.8	13.6
Installation of machines/equipment	63 (1.4)	423 (1.9)	18.9	25.1
Clearing, grading, excavating	14 (0.3)	387 (1.7)	18.6	25.8
Electrical	39 (0.9)	360 (1.6)	4.8	8.1
Conduits, sewers, tunnels, drilling	43 (0.9)	273 (1.2)	7.7	11.2
Manufacturing	887 (19.5)	4,483 (20.0)	2.7	3.7
Aircraft	228 (5.0)	1,316 (5.9)	2.0	1.9
Packing/canning, fruit and vegetable	33 (0.7)	374 (1.7)	2.7	5.2
Machine shops	54 (1.2)	363 (1.6)	5.5	9.4
Sheet/stamped metal	59 (1.3)	329 (1.5)	4.8	6.9
Structural metal; tank fabrication	102 (2.2)	218 (1.0)	8.4	12.0
Services, dealers, and professionals	946 (20.8)	5,832 (26.0)	0.6	1.0
Truck, bus, auto operation	92 (2.0)	915 (4.1)	3.8	6.2
Non-state government, NOC†	166 (3.6)	750 (3.3)	2.2	3.5
Vehicle service and accessories	91 (2.0)	623 (2.8)	2.0	3.1
Public utilities	98 (2.1)	556 (2.5)	2.9	6.0
State government, NOC	66 (1.4)	425 (1.9)	1.4	2.6
Materials and supplies dealers	51 (1.1)	376 (1.7)	2.8	4.4
Instructional professions	51 (1.1)	226 (1.0)	0.2	0.4
Building operation and maintenance	19 (0.4)	225 (1.0)	1.1	1.9
Aircraft operations	48 (1.1)	193 (0.9)	3.1	5.2
Miscellaneous	72 (1.6)	53 (0.2)	0.2	0.2
Hanford/DOE	47 (1.0)	978 (4.4)	11.2	36.4
Total	4,559	22,460	1.75	2.56

*Table displays industries with >25 claims/year during 1992–1998, sorted within larger industry categories by number of claims. The 1997–1998 claims are a subset of the 1992–1998 claims.

**Incidence = average number of claims per 1,000 full-time equivalent (FTE) workers per year. Incidence rates are not presented for 1984–1991 claims; necessary data were not available for Self-Insured claims.

†HVAC = heating, ventilation and air conditioning; NOC = not otherwise classified.

underlying increase in disease incidence, or if the increase primarily reflects changes over time in the reporting of disease to the workers' compensation system. This study, however, identified several phenomena that may help to define contributing factors. First, the claims increase and the average amount of associated impairment were less for Self-Insured claims than for State Fund claims. Second, the increased reporting was most pronounced for older individuals, particularly those who were older than the usual retirement age at the time of reporting, indicating that at least one stimulus for the claims increase probably has nothing to do with current work circumstances. Third, a very small percentage of health care providers or institutions were identified as the principal provider for a major proportion of claims accepted for hearing conditions. Fourth, although the increase in reported occupational hearing loss affected a

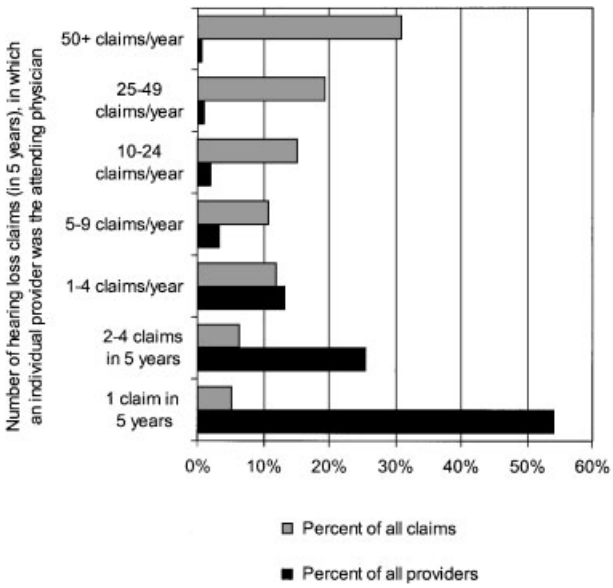

FIGURE 3. Hearing loss claims and providers, relative to the number of claims on which the provider was the attending physician (Washington State, 1992–1996).

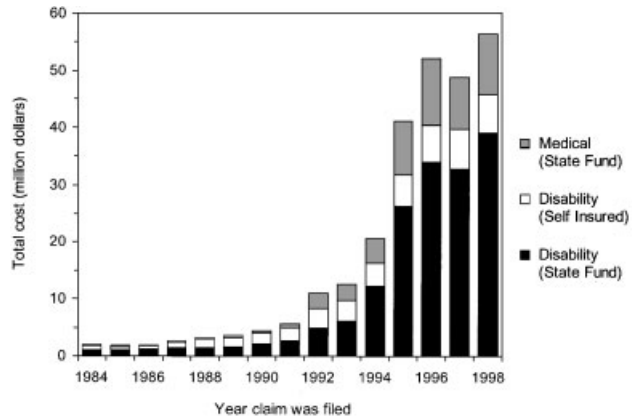

FIGURE 5. Workers' compensation costs for medical care and permanent partial disability, for occupational hearing loss claims in Washington State. Claims administered by the State of Washington for the federal DOE are included with "State Fund" claims in this figure. Medical expense data were not available for Self Insured claims.

broad range of industries, some were much more highly impacted than others.

We can only speculate about explanations for the differences observed between State Fund and Self-Insured claims. It is possible that the risk of hearing loss is truly lower at Self-Insured worksites. These relatively large employers might, on average, have more resources for controlling noise exposures, better hearing conservation programs, and relatively stable work forces that would benefit maximally from annual training and surveillance, compared to the generally smaller State Fund employers. Alternatively, the explanation might reflect differences in claim filing or claim management. For example, workers employed by a Self-Insured company might be more likely to have medical benefits that cover costs of medical evaluation and hearing aids, with less need to file a workers' compensation claim. Also, Self-Insured claims are managed by individuals who are more directly linked to the employer, than for State Fund claims, which are managed by State employees. Managers of Self-Insured claims probably have greater access to work place noise measurements and resources for claim investigations, which could make it easier to build a solid evidentiary foundation for rejecting claims where noise exposure was not clearly sufficient to cause hearing loss, or for arguing that the last injurious exposure occurred with a different employer and should be covered by the State Fund. Finally, Self-Insured employers may have greater access to attorneys, who could facilitate such claim decisions.

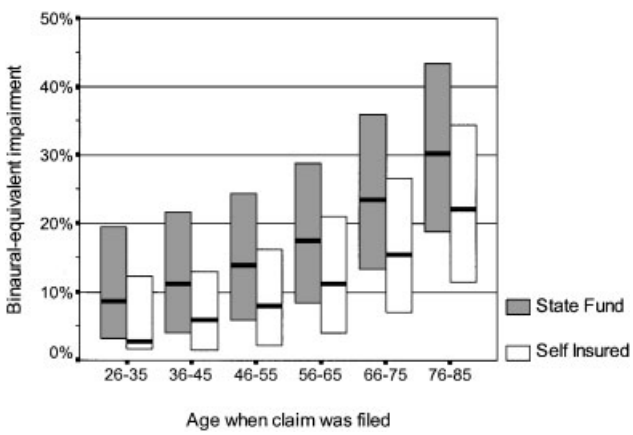

FIGURE 4. Hearing impairment in occupational hearing loss claims receiving disability compensation (Washington State, 1992–1998). Columns represent inter-quartile intervals; crossbars represent medians. Claims administered by the State of Washington for the federal DOE are included with "State Fund" claims in this figure.

Role of the Health Care Community

One contributing factor from outside the workplace may lie in the health care community, suggested by the disproportionate involvement of a very small number of providers on hearing loss claims. It is known that certain companies that conduct audiometric testing or that supply hearing aids have preferentially marketed their services to older individuals who formerly worked in noisy jobs. As one representative example, a yellow-colored flyer inserted in a major regional newspaper announced [Seattle Post-Intelligencer, 2001]:

> Work Place Hearing Loss ?? If you feel that you have a hearing loss which was caused by a work situation, whether present or in your past history, you may be eligible for compensation through Labor and Industry [DLI]. If you should qualify, based on Labor and Industry standards, you may

> receive state of the art hearing aids and the State will pay for them. In most cases, the State may also approve a cash settlement to compensate you for the effect the hearing loss has had on the quality of your life.

Another hearing-aid company was charged recently with conspiring to commit theft, by fraudulent billing to DLI [DLI, 2001]. The extent and impact of these phenomena is not known; and the concentration of claims among relatively active providers conceivably could be attributable to other provider-related factors, such as geographic proximity to noisy industries, established relationships with hearing conservation training or testing contractors, or willingness to work with the workers' compensation system. It is not surprising, however, that individuals who have hearing loss that arose from exposure to noise at work years or even decades ago, might not be troubled enough by their condition to file a workers' compensation claim until later in life, when their noise-induced hearing loss is compounded by aging-related hearing loss, presbycusis.

The paucity of occupational medicine physicians among the providers involved in reporting and evaluating occupational hearing loss, accounting for less than 1% of hearing loss claims, is at least noteworthy. There is probably a need for more involvement of physicians with specialized knowledge of the work environment, to ensure valid determinations of work-relatedness and to facilitate the public health application of clinical findings toward workplace improvements.

Relevance to Current Work Circumstances

Even though factors unrelated to current employment probably played a substantial role in the reporting increase, the large number of claims should not be dismissed as a reporting artifact with no relevance to current work circumstances. The reporting increase was not restricted to the retiree age bracket. The increase was substantial, and in general was associated with clinically significant levels of hearing impairment, for individuals 36 years and older; and presumably most of the younger individuals were actively employed at the time of claim filing.

The amount of hearing impairment covered by disability compensation undoubtedly over-estimates the amount of impairment that is truly attributable to occupational noise in a substantial proportion of cases, particularly older individuals who are susceptible to presbycusis, but also individuals who may have significant exposure to noise through activities outside of work.

Nonetheless, even if the increase in recognized cases reflects a reporting phenomenon with no relation to work conditions, and even if the amount of associated disability was over-represented by the available data, each reported case was judged by the workers' compensation system—after opportunities for employer protest and independent medical examination in questioned cases—to be a work-related condition, at least in major part. If these cases had never been reported, they still would have constituted a large number of true, albeit unrecognized, cases of occupational hearing loss. The reported cases still may represent only the tip of the iceberg. Conceivably, a similar increase could occur in any worker's compensation jurisdiction.

Many of the reported cases of occupational hearing loss may represent longstanding disease caused by noise exposure that occurred long before the 1983 OSHA Hearing Conservation Amendment (and the Washington State regulation) [Washington State, 1983]. Hearing ability is lost more rapidly in the earlier years of career-long noise exposure than in later years, such that an individual with career-long noise exposure will experience most of his or her noise-induced hearing damage in the first ten or twenty years of exposure [ISO, 1990; Lutman, 1992]. However, there is reason for concern that many of the historic noise sources that produced such long-existent hearing loss could still exist in recent or even current years, placing contemporary workers at risk for occupational hearing loss.

Current regulatory policy places primary emphasis on hearing conservation programs and secondary emphasis on noise controls for noisy workplaces. A hearing conservation program is required when workers' average noise exposures equal or exceed 85 dBA [OSHA, 1983; Washington State, 1983]. The requirement for noise control measures is not triggered until noise exposures exceed 90 dBA, and it is not enforced by OSHA until noise exposures exceed 100 dBA, if the cost of an effective hearing conservation program is less than the cost of feasible noise control measures. Sound intensity at 100 dBA is 32 times greater than that at 85 dBA. Unless hearing conservation programs are optimally effective in industries where noise exposures are allowed to remain above levels regarded as safe, current workers in those industries may still be at risk for having or developing occupational hearing loss.

The Washington State workers' compensation experience with hearing loss claims raises serious questions about the adequacy of contemporary hearing conservation practices, particularly the degree of attention to findings of audiometric monitoring. If the employed (or recently employed retiree) hearing-loss claimants reviewed in the present study were undergoing annual audiometric monitoring at work, as required since 1983 for noise-exposed workers, then their hearing loss probably was evident in workplace records for some period of time before it was eventually reported to the workers' compensation system. One critical component of any effective medical monitoring program should be the ongoing review of test findings, both clinically to identify whether individual workers need clinical evaluation, additional training, or improved protection, and epidemiologically to assess the effectiveness of protective actions in the workplace [Halperin et al.,

1986; Millar, 1986; Silverstein, 1994]. It is unlikely, however, that workers' compensation claim rates would have remained low for as long as they did in industries that eventually experienced high rates, if there had been a substantial and visible workplace reaction to a high prevalence of abnormal findings on audiometric testing.

Future Directions

Clearly, occupational hearing loss is a common condition, and in Washington State individual cases have been recognized with continually increasing frequency over the past decade. There is a need to determine if this increasing recognition simply represents new reporting of longstanding disease, or if it may further signal that contemporary workers remain at significant risk for hearing loss in spite of appropriate regulations to prevent such risk.

In theory, workers' compensation claims-based surveillance can be used to ''close the loop'' on an occupational disease, by directing interventions where the greatest potential exists to prevent that disease [Kaufman et al., 1994]. The present study identified highly impacted industries that represented less than 10% of the work force but accounted for half of all hearing loss claims. One next step should be to assess the extent of noise exposure, the effectiveness of hearing conservation programs, and the need, if any, for interventions in those industries.

Toward these ends, an ongoing study in Washington State is evaluating the status of hearing conservation programs at representative worksites in a variety of industries with high rates of hearing loss claims. The study includes a survey of recent hearing loss claimants, to characterize the factors that led to their filing a workers' compensation claim. In addition, a separate project is addressing the high rate of reported occupational hearing loss in construction industries, and the widely recognized lack of hearing conservation programs in those industries [Reilly et al., 1998], by establishing a model industry-wide hearing conservation program for building and construction trades in Washington State. Future reports will describe these endeavors.

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